APPLICATION FOR

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SPECIFICATION

INVENTOR(s): Yasushi URAKI

Title of the Invention: CONVERSION CHECK DEVICE, CONVERSION
CHECK METHOD, AND PORTABLE STORAGE
MEDIUM THEREFOR

CONVERSION CHECK DEVICE, CONVERSION CHECK METHOD, AND PORTABLE STORAGE MEDIUM THEREFOR

Background of the Invention

5   **Field of the Invention**

The present invention relates to the technology of checking used in converting product shape data generated by three-dimensional CAD, etc..

10   **Description of the Related Art**

In product development, etc., various analyses such as a thermal fluid analysis, etc. are conducted to evaluate a structure generated by three-dimensional CAD, etc. To perform these

15   analyses, the product shape data generated by three-dimensional CAD, etc. are converted into an analytic model appropriate for the analyses, and the analyses are conducted on the analytic model.

FIGS. 1A, 1B, 1C and 1D show examples of

20   converting a three-dimensional model based on the product shape data into an analytic model.

These figures show examples of converting a structure of a three-dimensional model based on the product shape data generated by three-dimensional

25   CAD into an analytic model. FIG. 1A shows the front

view of a three-dimensional model before conversion.
FIG. 1B shows the reverse side of the three-
dimensional model before conversion. FIG. 1C shows
the front view of the three-dimensional model after

5   conversion. FIG. 1D shows the reverse side of the
three-dimensional model after conversion.

An analytic model is generated by dividing an
original three-dimensional model by assigning a
grid pattern to it and determining the validity of

10   each rectangle element. Therefore, as shown in FIG.
1, an analytic model has an error between the
original three-dimensional model in shape, area,
volume, etc.

Since an analytic model obtained by conversion

15   has an error in shape, area, volume, etc., it is
probable the analytic model cannot be used in an
analyzing process depending on the level of the
error. The determination as to whether or not the
analytic model can be used in the analyzing process

20   has been conventionally made based on the empirical
rule of an operator.

That is, conventionally, three-dimensional
models before and after conversion have been
displayed as shown in FIG. 1, and an operator

25   visually checks the state of its shape, and

sensuously determines the acceptability of the analytic model. Therefore, for lack of quantitative determination standards, and due to personal discretion, the subsequent analysis result largely depends on the operator who normally continues the process. As a result, there has been the demerit that the accuracy (reliability) of the analysis result is affected by the sense of each operator.

Summary of the Invention

The present invention aims at providing a conversion check apparatus and a conversion checking method capable of notifying an operator of a difference between a generated analytic model and an original three-dimensional model, and allowing the operator to easily determine whether or not the analytic model can be used in an analyzing process.

The conversion check apparatus according to the present invention is based on the premise that an analytic model generated by converting a three-dimensional model for use in an analyzing process, and includes a computation unit and a conversion check display unit.

A calculation unit obtains a difference between the analytic model and the three-

dimensional model. The calculation unit includes at least one of, for example, a volume calculation facility unit for obtaining a difference in volume between the analytic model and the three-

5 dimensional model, a surface area calculation facility unit for obtaining a difference in surface area between the analytic model and the three-dimensional model, and a barycenter calculation facility unit for obtaining a difference in

10 barycenter position between the analytic model and the three-dimensional model.

The conversion check display unit displays the difference. The difference includes at least one of, for example, the above mentioned differences in

15 volume, surface area, and barycenter position.

The present invention also includes the conversion checking method and the portable storage medium in its scope.

Since the present invention can display the

20 difference between an original three-dimensional model and an analytic model converted for use in an analyzing process, the operator can appropriate and quickly determine the evaluation of the analytic model based on the difference.

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Brief Description of the Drawings

FIGS. 1A, 1B, 1C, and 1D show examples of converting a three-dimensional model based on product shape data into an analytic model.

FIG. 2 shows a configuration of the system and the entire process procedure according to an embodiment of the present invention;

FIG. 3 shows the details of the process performed by a three-dimensional CAD unit;

FIG. 4 shows the details of the process performed by the data conversion unit;

FIG. 5 shows the details of the process performed by the data conversion check facility unit and the volume calculation facility unit;

FIGS. 6A and 6B show examples of the data structures of a three-dimensional model converted by the data conversion unit;

FIG. 7 shows the details of the process performed by the surface area calculation facility unit;

FIG. 8 shows the details of the process performed by the barycenter position calculation facility unit;

FIG. 9 shows an example of a first display screen of a check result displayed by the

conversion check display facility unit;

FIG. 10 shows an example of a second display screen of a check result displayed by the conversion check display facility unit;

5   FIG. 11 shows an example of a third display screen of a check result displayed by the conversion check display facility unit;

FIG. 12 is a view of the system environment of a computer; and

10   FIG. 13 shows an example of a medium.

Description of the Preferred Embodiment

FIG. 2 shows a configuration of the system and the entire process procedure according to an
15 embodiment of the present invention. The system shown in FIG. 2 comprises a conversion check apparatus 1, a three-dimensional CAD unit 2, a data conversion unit 3, and an analysis unit 4. The conversion check apparatus 1, the three-dimensional
20 CAD unit 2, the data conversion unit 3, and the analysis unit 4 can be realized as independent devices or on one or more computers by a computer program.

The three-dimensional CAD unit 2 is used by an
25 operator in performing a process of generating a

three-dimensional model of a structure. When the operator input an instruction using an input appliance such as a mouse, etc. on the screen, the unit generates a three-dimensional CAD data

5 (product shape data) at the instruction (step S1), and outputs it as an intermediate file 21.

The data conversion unit 3 converts the three-dimensional CAD data stored as the intermediate file 21 by the three-dimensional CAD unit 2 into

10 the data of an analytic model, that is, generates an analytic model by dividing the three-dimensional model by assigning a grid pattern to it and determining the validity of each rectangle element, and outputs the analytic model as an intermediate

15 file 31.

The conversion check apparatus 1 according to an embodiment of the present invention numerically represents the differences in shape between the original three-dimensional model and the analytic

20 model converted by the data conversion unit 3. Then the operator can prescribe the equal determination standard using a threshold on the represented values. Furthermore, the conversion check apparatus 1 can practically display the shape change, and the

25 operator can actually determine the acceptability

of the analytic model.

The conversion check apparatus 1 checks the analytic model generated by the data conversion unit 3, and is configured by a conversion check facility unit 11, a volume calculation facility unit 12, a surface area calculation facility unit 13, a barycenter position calculation facility unit 14, and a conversion check display facility unit 15. The conversion check facility unit 11 allows the operator to select checking contents, reads the data of the three-dimensional model from the intermediate files 21 and 31, input the data into the volume calculation facility unit 12, the surface area calculation facility unit 13, and the barycenter position calculation facility unit 14, thereby performing the respective calculations. The volume calculation facility unit 12 obtains a change in volume between data before conversion and data after conversion. The surface area calculation facility unit 13 obtains a change in surface area between data before conversion and data after conversion. The barycenter position calculation facility unit 14 obtains a change in position of barycenter between data before conversion and data after conversion. The conversion check display

facility unit 15 indicates to the operator the changes between the data before and after conversion obtained by the conversion check facility unit 11, volume calculation facility unit 5 12, the surface area calculation facility unit 13, and the barycenter position calculation facility unit 14 by displaying each change on the screen or on print display, etc.

Since the conversion check apparatus 1 of the 10 embodiment is for checking for a thermal fluid analysis, the conversion check apparatus 1 makes checks on volume, surface area, and barycenter position changes. However, the present invention is not limited to these applications, but can be 15 applied to a three-dimensional analytic model in other fields of applications.

The operator determines whether or not the analytic model is to be used based on the contents displayed by the conversion check apparatus 1 (step 20 S9), the error of the analytic model does not much affect an analysis result, the analysis unit 4 performs an analyzing process using the analytic model if it is determined that the analytic model can be used in the analyzing process (YES in step 25 S9), and the conditions are amended and the data

conversion unit 3 generates another analytic model if the above mentioned analytic model cannot be used in the process (NO in step S9).

The analysis unit 4 performs various analyses such as a thermal fluid analysis, etc. using a three-dimensional model which has passed the check by the conversion check apparatus 1.

The analysis unit 4 reads data from the intermediate file 31 (step S4), fine-tunes the three-dimensional model, and completes an analytic model (step S5). Then, the boundary condition such as the temperature, etc. is set (step S6), an analyzing process is performed (step S7), and an obtained result is displayed (step S8).

Described below are the details of the processes performed the conversion check apparatus 1, the three-dimensional CAD unit 2, the data conversion unit 3, and the analysis unit 4.

FIG. 3 shows the details of the process performed by the data conversion unit 3.

The three-dimensional CAD unit 2 performs a process for generating a three-dimensional model of a structure. When the operator inputs an instruction about the shape of a structure using an input appliance such as a mouse, etc. on the screen,

the three-dimensional CAD unit 2 generates three-dimensional CAD data based on the input instruction, and outputs the data to the intermediate file 21.

According to the present embodiment, it is
5   assumed that a triangular (or triangular prism) structure 51 having a constant thickness is generated by the three-dimensional CAD unit 2 for ease of explanation.

FIG. 4 shows the details of the process
10   performed by the data conversion unit 3.

The data conversion unit 3 converts the three-dimensional model of the structure generated by the three-dimensional CAD unit 2 into a three-dimensional model for use in the analyzing process
15   performed by the analysis unit 4.

The data conversion unit 3 reads the target data of the three-dimensional model of the structure from the intermediate file 21, and divides the structure of the three-dimensional CAD
20   data into fine rectangular areas by assigning a grid pattern (with given spacing). Each rectangular area is checked whether or not the structure of the three-dimensional CAD data in the rectangular area has a volume of a specified value or more. A
25   rectangular area having a volume of a specified

value or more is valid, and the other rectangular area portions are invalid. The valid rectangular area contains a rectangle element of the volume of the size of the rectangular area, and the invalid rectangular area is considered to contain nothing and an analytic model is generated therein, and the generated analytic model is output to the intermediate file 31.

In the example shown in FIG. 4, a three-dimensional model 51 read from the intermediate file 21 is set with grid lines 52 set parallel to (hereinafter referred to as 'in the X direction of') one side of the bottom triangle, and with grid lines 53 perpendicular to (hereinafter referred to as 'in the Y direction of') the grid lines 52 and the bottom plane, at grid interval which is a default value or an operator-specified value (X = 12, Y = 6). Then, it is determined that the portion where the volume of the three-dimensional model in a rectangular area 54 enclosed by the grid lines 52 and 53 is 50% or more is valid, and the portion where the above mentioned volume is less than 50% is invalid. In the rectangular area of the valid portion, the rectangle element having the same size as the area is set, and the elements are removed

from the invalid rectangular area, thereby generating a three-dimensional model 55.

According to the present embodiment, since the thickness of a target structure has a predetermined

5   shape, the structure is assigned a grid pattern by the grid lines 52 and 53 in the two directions X and Y.   If the thickness is not uniform, the structure is also assigned a grid pattern in the Z direction perpendicular to the Y and X directions,

10   and represented in a three-dimensional array.

The analytic model generated by the data conversion unit 3 is checked by the conversion check apparatus 1 as to whether or not it can be used in an analyzing process.

15   FIG. 5 shows the details of the process performed by the conversion check facility unit 11 and the volume calculation facility unit 12 of the conversion check apparatus 1.

The conversion check facility unit 11 allows

20   the operator to select one or more checking contents made by the conversion check apparatus 1, and checks a three-dimensional model by the volume calculation facility unit 12, the surface area calculation facility unit 13 and the barycenter

25   position calculation facility unit 14.

The conversion check facility unit 11 displays the check item selection screen 61, and allows the operator to select the contents to be checked. Then, a target three-dimensional model is read from the

5 intermediate files 21 and 31, and input into the volume calculation facility unit 12, the surface area calculation facility unit 13, and the barycenter position calculation facility unit 14 according to one or more check items selected by

10 the operator, thereby performing various calculations.

In FIG. 5, the operator selects a volume error check as a check item, and the conversion check facility unit 11 outputs a three-dimensional model

15 read from the intermediate files 21 and 31 to the volume calculation facility unit 12.

The volume calculation facility unit 12 obtains the volume of the three-dimensional model before conversion by the data conversion unit 3 in

20 the intermediate file 21 and the volume of the three-dimensional model after conversion by the data conversion unit 3 in the intermediate file 31, and calculates the volume error (change amount) between the three-dimensional models before and

25 after conversion, and the volume error amount

(error amount from the three-dimensional CAD data).

According to the present embodiment, the three-dimensional CAD unit 2 generates the three-dimensional model 51 having a predetermined thickness of triangular (or triangular prism) shape. Therefore, the volume of the three-dimensional model 51 is obtained by {(bottom line length x height) / 2} x thickness.

Furthermore, the volume of the three-dimensional model 55 generated by assigning a grid pattern to the three-dimensional model based on the three-dimensional CAD data by the data conversion unit 3 is obtained by the calculation by (vertical length x horizontal length x thickness), and accumulating the volumes of the obtained rectangle elements.

Then, the volume calculation facility unit 12 calculates ratio between two volumes for a volume error, and the volume error amount indicating the number of rectangle elements in the grid pattern corresponding to the difference in volumes of three-dimensional models before and after conversion.

In FIG. 5, the volume calculation facility unit 12 obtains the volume error $C = (A - B) / A$

and the volume error amount = (A x C) / (vertical length x horizontal length x thickness of rectangle element in grid pattern) from the volume A of the three-dimensional model of the three-dimensional

5   CAD data = {(bottom line length x height) / 2} x thickness and the volume B of the three-dimensional model after conversion in grid pattern = $\sum$ (vertical length x horizontal length x thickness).

FIG. 6 shows an example of the data structure

10 of the three-dimensional model 55 converted by the data conversion unit 3.

The data of the three-dimensional model after conversion has the configuration of recording the coordinates of eight vertexes for each of n

15 rectangle elements forming the three-dimensional model as shown in FIG. 6A.

For the three-dimensional model data after conversion, the coordinate numbers 1 through 8 are determined as shown in FIG. 6 for the eight

20 vertexes of rectangle elements with the vertex (X1, Y1, Z1) of the coordinate number 1 of the rectangle element of the rectangle number 1 is represented by (0. 0, 0. 0, 0. 0), the vertex (X2, Y2, Z2) of the coordinate number 2 is represented by (10. 0, 0. 0,

25 0. 0), ..., the vertex (X8, Y8, Z8) of the

coordinate number 8 is represented by (10. 0, 10. 0, 10. 0), thereby recording the coordinates of the eight vertexes for all rectangle elements configuring the three-dimensional model.

5   The calculation of the volume B of the three-dimensional model after conversion in the grid pattern is obtained by calculating the volume of each rectangle element, and then the total volume is obtained from the sum of the calculation results. 10 In the case of the example shown in FIG. 6A, for example, the volume of the rectangle element of the rectangle number 1 is obtained as the horizontal length = X2 - X1, the vertical length = Y3 - Y1, and the thickness = Z5 - Z1. Using the obtained 15 values, the volume (= horizontal length x vertical length x thickness) of the rectangle element of the rectangle number 1 can be obtained. And a total volume of three-dimensional model 55 is obtained by accumulating the obtained volumes of the rectangle 20 elements.

FIG. 7 shows the details of the process performed by the surface area calculation facility unit 13.

The surface area calculation facility unit 13 25 obtains the surface areas of the three-dimensional

model before conversion by the data conversion unit
3 in the intermediate file 21 and the three-
dimensional model after conversion by the data
conversion unit 3 in the intermediate file 31, and
5 calculates the error (change amount) in the three-
dimensional models before and after conversion, and
the surface area error amount (the error amount for
the three-dimensional CAD data).

       In the present embodiment, the three-
10 dimensional CAD unit 2 generates the three-
dimensional model 51 having a predetermined
thickness of triangular (or triangular prism) shape.
Therefore, the surface area M of the three-
dimensional model 51 is obtained by (bottom line
15 length x height) + $\sum$ (length of each line x
thickness).

       Furthermore, the surface area N of the three-
dimensional model 55 generated by assigning a grid
pattern to the three-dimensional model based on the
20 three-dimensional CAD data by the data conversion
unit 3 is obtained by the calculation of (vertical
length x horizontal length x 2), (horizontal length
x thickness x 2), and (vertical length x thickness
x 2) on each element in the grid pattern, and the
25 obtained values are accumulated.

In an example of obtaining the surface area of
the three-dimensional model after conversion in the
data shown in FIG. 6, it is assumed that the front
side, back side, left side, right side, bottom
5   surface, and top surface respectively have the
following vertexes.

· front side: coordinate number 1, 2, 4, 3
       back side: coordinate number 5, 6, 8, 7
10   · left side: coordinate number 1, 5, 7, 3
       right side: coordinate number 2, 6, 8, 4
   · bottom surface: coordinate number 1, 2, 6, 5
       top surface: coordinate number 3, 4, 8. 7

15   where the surface area of the rectangle
elements of the rectangle number 1 is a sum of the
following results.

   · front and back side $(X2 - X1)$ x $(Y3 - Y1)$ + $(X6$
20   $- X5)$ x $(Y7 - Y5)$
   · left and right side $(Y3 - Y1)$ x $(Z5 - Z1)$ + $(Y4$
$- Y2)$ x $(Z6 - Z2)$
   · top and bottom surface $(Z5 - Z1)$ x $(X2 - X1)$ +
$(Z7 - Z3)$ x $(X5 - X1)$

25

Similarly, the surface areas of the rectangle elements of the rectangle numbers 2 ~ n are obtained and the sum of the results is calculated. The surface area of the overlapping surfaces (surfaces having adjacent rectangle elements) is subtracted from the sum.

The search for the overlapping surfaces is, for example, based on the rectangle element of the rectangle number 1, and a surface having matching coordinates of four vertexes with each surface of the rectangle elements of the rectangle number 1 is extracted from the surfaces of the rectangle elements of the rectangle numbers 2 ~ n. Then, based on the rectangle elements of the rectangle number 2, a surface having matching coordinates of four vertexes with each surface of the rectangle elements of the rectangle number 2 is extracted from the surfaces of the rectangle elements of the rectangle numbers 3 ~ n. Similarly, based on the rectangle elements of the rectangle number 3 ~ n, the surface having the matching coordinates of four vertexes is extracted. For example, if the rectangle element of the rectangle number 2 is located on the right of the rectangle elements of the rectangle number 1, then the right side of the

rectangle elements of the 1 and the left side of the rectangle elements of the rectangle number 2 have matching coordinates of four vertexes. Therefore, the two sides are to be deleted.

5   Thus, the areas of the extracted overlapping surfaces are calculated and subtracted from the total surface area of all rectangle elements to obtain the surface area of the three-dimensional model after conversion by the data conversion unit

10   3.

Then, the surface area calculation facility unit 13 calculates the ratio between two surface areas as a surface area error, and the surface area error amount indicating the number of rectangle

15   elements in the grid pattern corresponding to the difference.

In FIG. 7, the surface area error $O = (M - N) / M$ and surface area error amount $= (M \times O) /$ (vertical length x horizontal length x thickness of

20   rectangle elements in grid pattern) is obtained from the surface area M of the three-dimensional model based on the three-dimensional CAD data and the surface area N of the three-dimensional model after conversion in the grid pattern.

25   FIG. 8 shows the details of the process

performed by the barycenter position calculation facility unit 14.

The barycenter position calculation facility unit 14 obtains the barycenter positions of the three-dimensional model before conversion by the data conversion unit 3 in the intermediate file 21 and the three-dimensional model after conversion by the data conversion unit 3 in the intermediate file 31.

In the present embodiment, the three-dimensional CAD unit 2 generates the three-dimensional model 51 having a predetermined thickness of triangular (or triangular prism) shape. Therefore, the barycenter M of the three-dimensional model 51 is obtained by obtaining the intersection of the lines connecting each vertex of the bottom plane of the triangular prism and the center points of the opposing sides.

Furthermore, the barycenter position N (X, Y) of the three-dimensional model 55 generated by assigning a grid pattern to the three-dimensional model based on the three-dimensional CAD data by the data conversion unit 3 is obtained by obtaining the barycenter position of each rectangle element, accumulating the sum of the products obtained by

multiplying the distance (i, j) from the barycenter position of each grid element to the origin by the volume n(i)(j) of each grid element, and dividing the result by the total volume W = $\Sigma \Sigma$ n(i)(j) of

5 the three-dimensional model 55 after conversion.

In an example of obtaining the barycenter position of the three-dimensional model after conversion in the data shown in FIG. 6, the barycenter position of the rectangle elements of

10 the rectangle number 1 is obtained as follows.

· coordinates X in X direction: (X1 + (X2 - X1)) / 2

· coordinates Y in Y direction: (Y1 + (Y3 - Y1)) / 2

· coordinates Z in Z direction: (Z1 + (Z5 - Z1)) / 2

15

Similarly, the barycenter position is obtained for the rectangle elements of the rectangle numbers 2 ~ n.   Then, the X coordinate of the barycenter position N of the three-dimensional model 55 is (1

20 / W) Σ (X x w), the Y coordinate is (1 / W) Σ (Y x w), the Z coordinate is (1 / W) Σ (Z x w).(The volume w is a volume of the rectangle element.)

FIG. 9 shows an example of the display screen of a check result displayed by the conversion check

25 display facility unit 15.

FIG. 9 shows the results of the checks on volume, surface area, and barycenter, and shows the error display, error amount, barycenter transfer, difference, etc. are displayed in a separated

5 screen based on selection buttons 78a through 78e.

In the example shown in FIG. 9, a three-dimensional model shape 71 based on the three-dimensional data with barycenter positions 73 is displayed parallel to a three-dimensional model

10 shape 72 after conversion by the data conversion unit 3 with barycenter positions 74, and a volume error 75 and a surface area error 76 of two three-dimensional models are displayed on a % basis as check results. Then, the error amounts of volume

15 and surface area (volume error amount and surface area error amount) are visually displayed with an error amount 77 indicating the number of rectangle elements corresponding to the error of a unit of volume (surface area) of one rectangle element.

20 On the display screen shown in FIG. 9, when the operator switches ON/OFF of the selection buttons 78a through 78e on the screen, the display contents can be changed.

In the example shown in FIG. 9, there are a

25 volume error 78a indicating the calculation result

by the volume calculation facility unit 12, a
surface area error 78b indicating the calculation
result by the surface area calculation facility
unit 13, a barycenter 78c indicating the
calculation result by the barycenter position
calculation facility unit 14, a overlap 78d, and a
difference 78e.   In the selection buttons, the
volume error 78a, the surface area error 78b, and
the barycenter 78c are set ON, and the calculation
result by the volume calculation facility unit 12,
the calculation result by the surface area
calculation facility unit 13, and the calculation
result by the barycenter position calculation
facility unit 14 are displayed.

FIG. 10 shows an example of the display screen
where the overlap selection button 78d is set ON.

When the overlap selection button 78d is set
ON, the three-dimensional model shape 71 of the
three-dimensional data and the three-dimensional
model shape 72 after conversion by the data
conversion unit 3 are displayed as overlapped with
the barycenter positions 73 and 74 as shown in FIG.
10. At this time, the three-dimensional model shape
71 before conversion is displayed as a
semitranslucent image for visibility.

FIG. 11 shows an example of a display screen where the selection buttons 78a, 78b, 78d and 78e are set ON.

On the display screen shown in FIG. 11, since
5   the difference selection button 78e is set ON, the difference between the shape of the three-dimensional model of three-dimensional data and the shape of the three-dimensional model after conversion by the data conversion unit 3 is
10 visually displayed.

In FIG. 11, for each rectangle element, the portion not completely overlapping between the three-dimensional model shape 71 of three-dimensional data and the three-dimensional model
15 shape 72 after conversion by the data conversion unit 3, that is, the overlapping portions of the shapes by 50% or more ~ less than 100%, and by less than 50% are respectively represented by diagonal lines and grid lines. That is, between the three-
20 dimensional model shape 71 of three-dimensional data and the three-dimensional model shape 72 after conversion by the data conversion unit 3, the rectangle element having an overlapping portion less than 50% in volume is expressed by diagonal
25 lines 81, and the rectangle element having an

overlapping portion by 50% or more ~ less than 100%
is expressed by grid lines 82. In this example, the
100% overlapping grid elements are not specifically
expressed, but the differences are emphasized by
5   the shapes 71 and 72.

The operator operates the selection buttons
78a through 78e, and can check the changes in the
three-dimensional   models   before   and   after
conversion. The changes in shape can be expressed
10   numerically or visually. Therefore, the operator
can compare values with a threshold, compare errors
expressed   visually,   etc.,   thereby   sufficiently
checking the errors of items largely influencing
the analyzing process performed by the analysis
15   unit 4.

Then,   the   operator   determines   whether   the
analyzing process by the analysis unit 4 is to be
performed   using   the   analytic   model,   or   the
conditions   are   to   be   changed   to   allow   the   data
20   conversion unit 3 to generate an analytic model.

For example, in the thermal fluid analysis,
the important items are a volume for heat capacity,
and a surface area for a radiation area. The
conversion   check   apparatus   1   according   to   the
25   present embodiment can present (show) to the user

the comparison results between three-dimensional models in volume and surface area numerically (error %). Furthermore, the error in shape is presented, and the difference between current shape

5 and converted shape is displayed.

In the structural analysis field, the shift of the barycenter position is important, and the conversion check apparatus 1 can display the comparison result on the barycenter positions of

10 the three-dimensional models before and after conversion.

FIG. 12 shows the system environment of the computer where all or a part of the functions of the system shown in FIG. 2 are realized on the

15 computer.

The computer shown in FIG. 12 comprises a CPU 91, a main storage device 92 used as a work area of each program, an auxiliary storage device 93 such as a hard disk, etc. storing each program and a

20 database, an input/output device (I/O) 94 such as a display, a keyboard, etc., a network connection device 95 such as a modem, etc., and a medium read device 96 for reading stored contents from a portable storage medium such as a disk, a magnetic

25 tape, etc. These components are interconnected

through a bus 98.

When the functions of the conversion check apparatus 1, the three-dimensional CAD unit 2, the data conversion unit 3, and the analysis unit 4 are

5   realized by software, the CPU 91 reads data from the area of main storage device 92 or the auxiliary storage device 93 by using the main storage device 92 as a work area.

The computer shown in FIG. 12, the medium read

10   device 96 reads a program and data stored on a storage medium 97 such as a magnetic tape, a flexible disk, CD-ROM, MO, etc., and downloads them into the main storage device 92 or the auxiliary storage device 93. Then, each process according to

15   the present embodiment can be realized as a function of software by the CPU 91 executing the program and data.

Furthermore, the computer shown in FIG. 12 can exchange application software using the storage

20   medium 97. Therefore, the present invention is not limited to the conversion check apparatus or the conversion checking method, but can be configured as a program used to direct a computer to perform the functions according to the above mentioned

25   embodiments of the present invention, and the

computer-readable storage medium 97 storing the program.

In this case, the 'storage medium' can be, for example, a portable storage medium 106 removable

5   from or attachable to the medium drive device 107 such as CD-ROM, a flexible disk (or MO, DVD, removable hard disk, etc.) as shown in FIG. 13, a storage unit (database, etc.) 102 in an external device (server, etc.) transmitted through a network

10 circuit 103, memory (RAM, a hard disk, etc.) 105, etc. in a body 104 of a computer 101, etc. The program stored in a portable storage medium 106 and the storage unit (database, etc.) 102 is loaded into the memory (RAM, a hard disk, etc.) 105 in the

15 body 104 for execution.

According to the present invention, a unified determination standard can be obtained by numerically representing a change state of the shapes before and after conversion.

20 Additionally, various items required in checking an analytic model can be visually displayed.

Therefore, an analytic model after conversion can be safely used, and the precision of an

25 analysis result can be improved.

Furthermore, since the changes in shape before and after conversion can be numerically or visually represented, it can be quickly determined whether or not a generated analytic model can be used in an analyzing process, thereby shortening the time required in generating an analytic model.